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A preliminary assessment of the potential risks from electrical infrastructure to large birds in Kenya

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Summary

A rapid risk assessment of the interactions between Kenya's large birds and electrical infrastructure was conducted around Magadi and Naivasha in Kenya in January 2009. Six out of the seven <132 kV distribution pole designs assessed pose an electrocution risk to medium and large-sized birds. Several sites of high bird collision risk were identified. Several of the observed >132 kV transmission tower structures were vulnerable to electrical faulting caused by birds. Of approximately 24 relevant bird species that are of conservation concern in Kenya, 17 (71 %) face a high risk of direct interactions with electrical infrastructure. Priority species for attention include the Egyptian Vulture *Neophron percnopterus*, White-headed Vulture *Trigonoceps occipitalis*, Lappet-faced Vulture *Torgos tracheliotos*, Grey-crowned Crane *Balearica regulorum*, Lesser Flamingo *Phoeniconaias minor*, White-backed Vulture *Gyps africanus*, Rüppell's Vulture *Gyps rueppellii*, Martial Eagle *Polemaetus bellicosus*, White Stork *Ciconia ciconia*, Secretarybird *Sagittarius serpentarius*, and various sit-and-wait raptors. These preliminary findings have national relevance given plans (already underway) for a rapid expansion of electrical infrastructure in Kenya; recommendations are made for a national response to this matter.

Introduction

Due to its size and prominence in the landscape, electrical infrastructure constitutes an important interface between wildlife and man. Direct interactions between electrical infrastructure and wildlife include electrocution, collision with power lines, and short circuiting of the electricity supply. Indirect interactions include destruction of wildlife habitat and disturbance of wildlife as a result of infrastructure construction and maintenance activities. This paper focuses on the direct interactions only.

Electrocution of birds on overhead lines is an important cause of unnatural mortality of raptors, storks and other species in South Africa (Eskom-EWT Strategic Partnership's Central Incident Register, *unpubl. data*), and has attracted plenty of attention in Europe and the USA (APLIC 1994, van Rooyen & Ledger 1999, Bevanger 1998). Electrocution occurs when a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004). Species such as vultures, eagles, hawks, storks, and owls are the ones most commonly killed through electrocution (Bevanger 1998). Mitigation of existing infrastructure is achieved through insulating certain components on the poles, whilst new infrastructure can be designed safely from the start (van Rooyen & Smallie 2006).

Collisions with overhead cables are the biggest single threat posed by the larger transmission (>132kV) power lines to birds in southern Africa (van Rooyen 2004). Collisions are caused by the inability of the bird to see the cables until it is too late to take evasive action; they affect heavy-bodied birds with limited manoeuvrability the most (Anderson 2001, van Rooyen 2004). Species such as the cranes, flamingos, storks, bustards, waterfowl, shorebirds and falcons are frequent collision victims. For existing power lines, mitigation involves marking the line with anti-collision marking devices to increase its visibility to birds (van Rooyen & Smallie 2006), whilst new power lines should be carefully routed to avoid major flight paths.

Birds can cause electrical faults through streamers, pollution or nesting. Though birds are seldom injured or killed, these faults can adversely affect the quality of electrical supply to customers. A bird streamer is a long spurt of excrement, which when produced by a bird perching on an electrical pole or pylon, may bridge the "air gap" between live and grounded hardware, thereby resulting in a short circuit (Taylor *et al.* 1999). Bird pollution refers to the accumulation of bird excrement on insulator strings—the device insulating the conductor cable from the pole or pylon—which weakens the insulation properties of the string. Birds also sometimes nest on electrical structures, potentially bridging the air gap with nest material (particularly conductive material, such as wire used by crows). Problems associated with streamers and pollution are mitigated by preventing the birds from perching on high risk areas of towers or poles, or by constructing perch deterrents (van Rooyen & Smallie 2006), while those associated with nesting are managed by relocating problematic nests to safer areas of the tower.

Methodology

Study sites and risk assessment

A rapid preliminary risk assessment of electrical infrastructure was conducted in two areas of Kenya: i) along the Nairobi-Magadi-Elangata-Wuas-Kajiado-Nairobi circuit (hereafter the Magadi Circuit), and ii) along the Nairobi-Longonot-Naivasha-Hell's Gate-Nairobi circuit (hereafter the Naivasha Circuit). These sites were chosen for their accessibility, known existence of extensive power line networks, and presence of the relevant bird species. Each circuit was visited and driven for two days, amounting to a total of 250 and 220 km for the Magadi and Naivasha circuits, respectively. During this time, all relevant electrical structures were assessed for the risk that they pose to birds or the potential for birds to cause electrical faults on this infrastructure, based on experience of similar structures and species in South Africa. In addition, the potential for interactions between birds and likely future infrastructure was assessed, based on identifying nodes of likely future development requiring electrification.

Bird species likely to interact directly with electrical infrastructure

A rapid assessment of the bird species at highest risk of direct interaction with electrical infrastructure throughout Kenya was conducted. Species were selected based on two qualities: their perceived risk using the South African experience; and their conservation importance, based on classifications like the IUCN Red Data List (2009) and the Bonn Convention on Migratory Species (Bonn 1979) amongst others. Each species was assessed for its vulnerability to direct interaction with electrical infrastructure, i.e. electrocution, collision and electrical faulting. The overall significance of this risk was assessed on a scale of high, medium and low, as was the overall priority for addressing interactions for the species. This prioritisation took into account the species conservation status/importance, endemism, and likely scale or volume of interactions. Factors such as the species social behaviour are particularly important, since gregarious species such as vultures are more vulnerable to electrocution than solitary eagles for example.

Results and Discussion

Electrocution risk

Across both circuits, a total of seven different distribution (<132 kV) pole configurations were observed. This excludes various permutations of "in line strain" (bend) and "terminal" (transformer) structures, and the apparent large diversity of structures used in urban areas. Of the seven, six were considered to pose a high risk to medium to large perching birds, such as the "T-pole" (Fig. 1a). A bird with a wingspan greater than about 110 cm, perched on the cross arm, can touch two conductors simultaneously and get electrocuted. The "inverted T" (Fig. 1b) is considered safe because suspension of the outer conductors below the cross arm places them out of reach of a perching bird. Though we did not undertake any formal quantification of the length of line with each pole configuration in each circuit, it appears that unsafe pole structure represents the vast majority of power line by length in both circuits. All transmission structures (>132 kV) were considered to pose low electrocution risk by virtue of the large clearances between live hardware. The extent of electrification was lower in the Magadi circuit compared to the Naivasha one, suggesting that, all other factors being equal, the Naivasha Circuit may be expected to pose a greater risk of interaction to birds in the area. A more detailed risk assessment would relate power line density to bird species abundance more formally.

Figure 1a & b. 1a (on the left) shows the typical "T-structure" which poses an electrocution risk to birds perching on the cross arm. 1b shows the "inverted T" pole structure which is safer for perching birds since the outer conductors are suspended below the cross arm out of reach of birds.

Collision risk

For bird collision, the risk is determined less by the design of the electrical structure than by the surrounding habitat and species present. On the Magadi Circuit, habitat likely to attract collision-susceptible species such as bustards and storks was observed in several places. This is mainly open vegetation and areas where open water may stand after heavy rain. On the Naivasha Circuit, the potential for collision is far greater, because water bodies around the lake and in the associated agricultural areas support collision-vulnerable species such as flamingos, storks and cranes. Also, intensive human occupation and agriculture has led to greater electrification in this area, further increasing the risk.

Electrical faulting risk

Electrical faulting occurs mainly on transmission lines (>132 kV). In total, three transmission tower structures were observed on both circuits. Without access to tower design diagrams and dimensions, a definite assessment was not possible.

Bird species likely to interact directly with electrical infrastructure

A total of 24 species were assessed individually, while 'waterfowl and shorebirds', and 'sit-and-wait' raptors were assessed collectively. Of the 24 species, 18 (or 75 %) are judged to face a high risk of direct interaction with electrical infrastructure, 5 (21 %) a medium risk, and one species a low risk (Table 1). High risk species, typically the larger ones, were those which have established high vulnerability to interactions in South Africa. The following 10 species emerged as highest priority for conservation attention: Egyptian Vulture, White-headed Vulture, Lappet-faced Vulture, Grey-crowned Crane, Lesser Flamingo, White-backed Vulture, Rüppell's Vulture, Martial Eagle, White Stork, and Secretarybird. Various sit-and-wait raptors were also high risk, whilst waterfowl and shorebirds were medium risk. Sit-and-wait raptors such as Augur Buzzard *Buteo Augur* and Long-crested Eagle *Lophaetus occipitalis* are particularly vulnerable due to the frequency and duration with which they sit on electrical poles. The Augur Buzzard has already shown a 55 % decline at Lake Naivasha, with electrocution being a suspected contributing factor (Virani 2006).

While management efforts could initially focus on the high risk species, species such as Heuglin's Bustard *Neotis heuglinii* and Black-crowned Crane *Balearica pavonina* have been assigned medium priority (Table 1) due to their relatively localised distribution in Kenya. This does not mean that impacts on these species are less important, but rather that it would be better to focus initial efforts on more widespread, frequently-impacted species. Besides, it is likely that if infrastructure designs are made safe for the high risk species (e.g., large vultures), benefits will accrue to the smaller ones too.

Table 1. Preliminary assessment of the vulnerability of the relevant bird species to interactions with electrical infrastructure (EN: Endangered; VU: Vulnerable; NT: Near-threatened; E: Electrocution; C: Collision; F: Electrical faulting).

Common name	Scientific name	IUCN conservation status (2009)	Bonn Convention	Likely interactions	Overall risk of interaction	Overall priority for management action
Egyptian Vulture	*Neophron percnopterus*	EN	Appendix 1	E	High	High
Saker Falcon	*Falco cherrug*	EN		C	Medium	Medium
White-headed Vulture	*Trigonoceps occipitalis*	VU		E, F	High	High
Lappet-faced Vulture	*Torgos tracheliotos*	VU		E, F	High	High
Grey Crowned Crane	*Balearica regulorum*	VU		C	High	High
Maccoa Duck	*Oxyura maccoa*	NT		C	Low	Low
Lesser Flamingo	*Phoeniconaias minor*	NT	Appendix 2	C	High	High
Red-footed Falcon	*Falco vespertinus*	NT		C	Medium	Medium
Sooty Falcon	*Falco concolor*	NT		C	Medium	Medium
Taita Falcon	*Falco fasciinucha*	NT		C	Medium	Medium
White-backed Vulture	*Gyps africanus*	NT		E, F	High	High
Ruppell's Vulture	*Gyps rueppelli*	NT		E, F	High	High
Southern Banded Snake Eagle	*Circaetus fasciolatus*	NT		E	High	Medium
Bateleur	*Terathopius eccudatus*	NT		C	Medium	Medium
Martial Eagle	*Polemaetus bellicosus*	NT		E	High	High
Eastern Imperial Eagle	*Aquila heliaca*	NT		E	High	Medium
Greater Spotted Eagle	*Aquila clanga*	NT	Appendix1/2	E	High	Medium
Denham's Bustard	*Neotis denhami*	NT		C	High	Medium
Black-crowned Crane	*Balearica pavonina*	NT		C	High	Medium
White Stork	*Ciconia ciconia ciconia*		Appendix 2	C	High	High
Woolly-necked Stork	*Ciconia episcopus microscelis*		Appendix 2	C	High	Medium
Black Stork	*Ciconia nigra*		Appendix 2	C	High	Medium
Yellow-billed Stork	*Mycteria ibis*		Appendix 2	C	High	Medium
Heuglin's Bustard	*Neotis heuglinii*					Medium
Various sit-and-wait raptors				E	High	High
Various waterfowl & shorebirds			Appendix 2	C	Medium	Low

Conclusion and Recommendations

There is considerable risk of direct interaction between large birds and the current state of electrical infrastructure in Kenya, with several key species of conservation concern at risk. It is important that this issue be approached comprehensively in the near future especially with growing electrification around the country. Kenya can learn a few lessons from South Africa, a country with far greater extent of electrification. In response to bird-power line interactions, a strategic partnership was initiated in 1996 between Eskom, South Africa's national electricity supplier, and the Endangered Wildlife Trust (EWT), a non-profit organisation dedicated to the conservation of biodiversity in southern Africa (van Rooyen & Smallie 2006). This partnership has employed a co-operative, non-confrontational approach to the problem. It runs through several programmes including: information and advocacy; incident reporting and investigating; mitigation; research; and impact assessment for new infrastructure. Unfortunately, vast lengths of power line were constructed in South Africa prior to awareness and understanding of the aforementioned interactions. The Eskom-EWT Strategic Partnership is now addressing this backlog of unsafe infrastructure in addition to ensuring that new infrastructure is built in a bird-friendly manner. While we cannot go into a detailed description of these actions here, the overriding lesson is that it is imperative that the relevant authorities join hands early on in Kenya. Various leaders, organisations, and forums have agreed that increasing the electrification of Kenya is a top priority (NEC 2008). The timing is therefore critical if Kenya is to ensure that the electrification takes place in an environmentally friendly manner from the outset. The national response requires a combination of applying mitigation to existing infrastructure in priority areas and ensuring that new infrastructure is safely built. We propose the following five actions as a start:

1. A Kenyan conservation organisation (e.g., the National Museums of Kenya NMK) takes the lead in addressing this issue by developing a formal, working relationship with the key players in the electrical industry, specifically Kenya Power & Lighting Company (KPLC) and Kenya Electricity Generation Company Limited (KenGen).
2. This partnership jointly conducts a thorough national risk assessment of the interactions between birds and existing (and planned) electrical infrastructure in Kenya, from which a central database is developed and maintained by the conservation organisation in order to collate all reported information on bird interactions with electrical infrastructure.
3. The partnership also holds regular workshops across the country to enhance public awareness and understanding of these matters. This will also encourage reporting of interactions and inter-sectoral collaborations.
4. Capacity in this specialised field should be developed within the staff of the relevant organisations in the partnership (e.g., NMK and Kenya Wildlife Service). They can learn a lot from sharing experiences with the EWT, e.g., through staff exchange programmes.

5. Finally, funding will be necessary for all of these activities; KPLC and KenGen ought to take a lead in financing some initial activities, both because it is a good business move (through reduction of losses associated with interactions with birds) and it will lessen the impact of their activities on the environment.

Conservationists and the electrical industry in Kenya are faced with both a daunting challenge and a huge opportunity of ensuring that current and future electrical infrastructure in Kenya is managed and constructed in an environmentally-friendly manner. Success in this regard will mean both economic benefits to the relevant companies and the economy, as well as a huge contribution to the conservation of biodiversity, especially birds. We hope that this paper flags some important issues and provides basic information that will contribute to developing the required response to this matter in Kenya.

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References

Anderson, M.D. 2001. *The effectiveness of two different marking devices to reduce large terrestrial bird collisions with overhead electricity cables in the eastern Karoo, South Africa*. Draft report to Eskom Resources and Strategy Division. Johannesburg. South Africa.

Avian Power Line Interaction Committee (APLIC). 1994. *Mitigating Bird Collisions with Power Lines: The State of the Art in 1994*. Edison Electric Institute. Washington D.C.

Bevanger, K. 1998. Biological and conservation aspects of bird mortality caused by electricity power lines: a review. *Biological Conservation* 86: 67-76.

Bonn 1979. *The Bonn Convention on the Conservation of Migratory Species of Wild Animals*. Environmental Policy and Law, Volume 5, Issue 3, p156.

IUCN 2009. *IUCN Red List of threatened species*. Downloaded from www.iucnredlist.org on 25/5/ 2009.

NEC 2008. *National Energy Conference held in Nairobi*. Downloaded from www.kenyaengineer.or.ke on 25/5/2009.

Taylor, P.V., Vosloo, H.F., Wolmarans, C.C.E., Britten, A.C., Naidoo, P., Hoch, D.A. & van Rooyen, C.S. 1999. *"Unknown" category of MTS line faults; bird streamers as a cause of transient earth faults.* Progress Report, July 1999. Eskom Transmission Group.

van Rooyen, C.S. & Ledger, J.A. 1999. *Birds and utility structures: Developments in southern Africa.* in Ferrer, M. & G..F.M. Janns. (Eds.) Birds and Power lines. Quercus: Madrid, Spain, pp 205-230.

van Rooyen, C.S. 2004. *The Management of Wildlife Interactions with overhead lines.* In: The fundamentals and practice of Overhead Line Maintenance (132kV and above), pp217-245. Eskom Technology, Services International, Johannesburg.

van Rooyen, C.S. & Smallie, J. 2006. The Eskom – Endangered Wildlife Trust Strategic Partnership in South Africa: A brief summary. *Nature & Faune*, Vol. 21, Issue 2: Pp. 25.

Virani, M. Z. 2006. In Steep Decline. *Swara* April-June 2006.

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